Study of the Tannin Contents of Barks from the Florida Scrub Oaks *Quercus laevis and Q. cinerea*+°

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At the end of the nineteenth century, the United States was self-sufficient with respect to vegetable tannins for production of heavy leather. Oak bark and eastern hemlock bark constituted the chief source of these materials [26]. By 1939, domestic supplies had shrunk to about 37 per cent of the total needs; chestnut wood supplied nearly 35 per cent and oak and hemlock barks less than 2 per cent. Tanners formerly preferred the bark of chestnut oak [19], but as the supply of this decreased, the barks of other oaks were used. At present, use of all these domestic vegetable tannins is rapidly decreasing, the chestnut as a result of blight [28], the oak and hemlock because of the scarcity of readily available supplies, higher labor costs, and availability of other high-grade tanning extracts.

The inadequacy of domestic sources of vegetable tannins, emphasized by the war, has prompted several efforts to find new domestic sources [2, 3, 4, 9, 10, 13, 14, 15, 17, 18, 20, 21, 22, 23, 24, 25]. One investigation [23] of plant sources included several species of scrub oaks. Another [16] showed that the barks of some of these scrub oaks merited an intensive examination to determine their suitability for commercial use.

The feasibility of the commercial use of these barks has been studied in a cooperative research project between the Eastern Regional Research Laboratory of the United States Department of Agriculture and the Engineering and Industrial Experiment Station of the University of Florida. The project was

originally planned to include the following objectives: (1) A survey of scrub oaks and the location of suitable stands containing bark which has acceptable tannin content and is adequate for the proposed semi-commercial tests; (2) development of a feasible method for removal of bark; and (3) procurement, by the method developed, of 200 tons of air-dry bark for use by a commercial extract plant to produce tanning extract for semi-commercial tanning tests.

The work reported in this paper deals primarily with the first of these objectives, namely, the selection of several areas from any of which the required quantities of bark could be obtained; and the systematic study of the tannin contents of the barks of the three most promising scrub oaks—*Quercus laevis*, *Q. cinerea* and *Q. marilandica* [1 6]—to establish their suitability for commercial use in production of tanning extract. These studies included determination of the tannin contents of barks from trees of the different species, from different trees in the same area, from trees growing in different parts of Florida, and from different parts of the same tree, including trunk, tops and limbs. Incidental data have been obtained on seasonal variation in tannin content.

In a previous paper [6] Calderwood and May proposed a method by which the chipped bark and wood from trees and limbs of various sizes can be separated by air flotation. This procedure, directed toward accomplishment of the second objective, would eliminate hand peeling of the bark and make possible the salvage of limbs and branches. In the studies reported here it was assumed that this method or one giving similar results could be used economically.

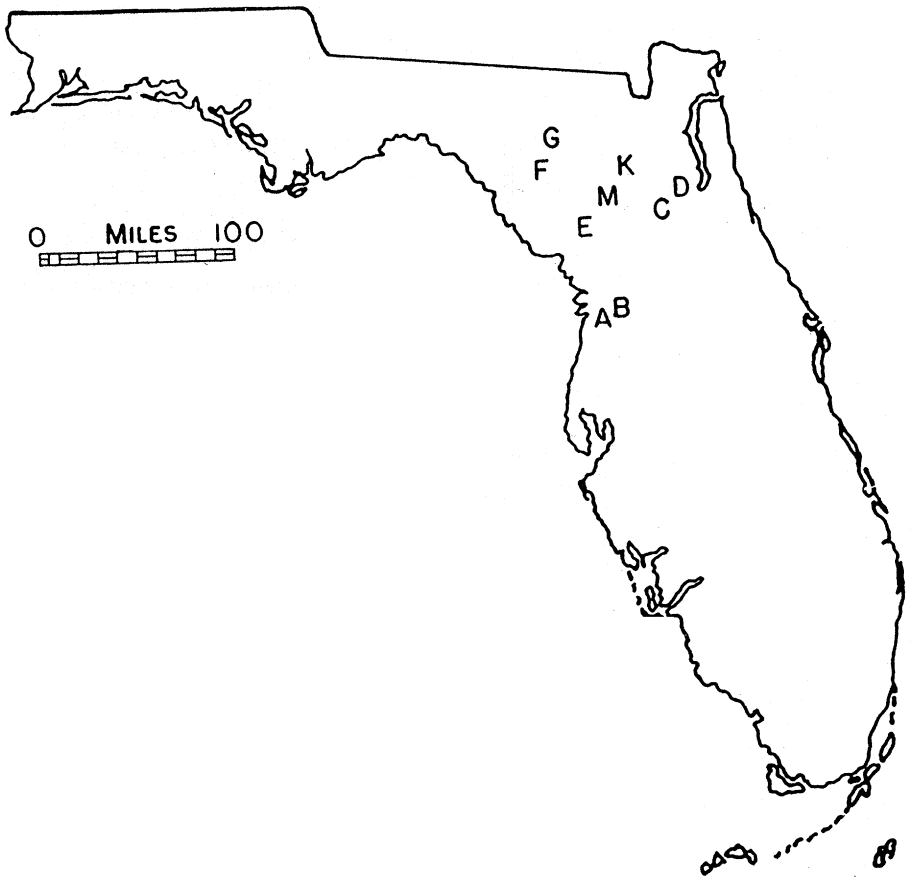
Other papers [5], [6], [7] have reported the forestry aspects of the project, including the extent and distribution of these oaks in Florida, estimates of the total quantity of bark available, and the probable number of extract plants that could be supplied with oak bark under a sustained yield basis of forest management.

The third objective of this project has not yet been attained.

Sampling of Bark

The plots designated A-G inclusive (Figure 1) encompassed the principal areas in Florida in which scrub oaks occurred. Each could supply more than the quantity of bark needed for item 3 of the project. Plot K was located in the Austin Cary Forest of the University of Florida. Plot M consisted of two tracts. All plots except K were privately owned and contained fire-injured trees.

Because Turkey oak, *Quercus laevis* Walt, was by far the most abundant of the three species [8] originally intended for investigation, its bark was collected as the representative material from 6 of the plots (B-G). Bluejack oak, *Q. cinerea* Michx., occurred only as scattered trees, rarely amounting to more than



10 per cent of the stands, on all the plots except Plot A, which had a stand of this oak sufficient to meet the project requirements, and Plots K and M, where samples of both species were collected. Since none of the plots contained blue-jack oak, *Q. marilandica* Muenchh, it was omitted from the study.

The method adopted for sampling of bark in the first 7 plots selected for study (A-G) was as follows: (1) Select an area containing scrub oak trees sufficient to produce the 200 tons of bark required for a semicommercial test. (2) Locate 7 representative plots in this area. (3) In each plot, select (a) the most representative tree and (b) the 10 trees, including the one under (a) that most truly represent the plot. Fell all trees selected for sampling. (4) From the tree selected under (3a), collect sufficient bark to produce 2 pounds of air-dried bark from each of the following positions: 6 inches above the base of the tree; breast height; center point of trunk; 6 inches below top end of log.

(5) Sample the remaining 9 trees from each plot at breast height. (6) Air dry all samples to approximately 12 per cent moisture under suitable conditions to prevent molding.

Comparison of Age and Size of Trees

When the samples were taken, measurements were made of the height of each tree and of the diameter at the butt, at breast height, at the middle of the trunk, and at the top of the trunk. The age of the tree was determined from a polished transverse section cut from the lower end of the green butt log with a fine-tooth band saw. Because of fire damage, disease and other factors, it was not possible in all cases to determine the ages of the trees accurately. Some trees were actually older than recorded. Nevertheless, a comparison was made of the ages of the trees and their dimensions, based on the available data (Table I). The data for 93 *Quercus laevis* and 35 *Q. cinerea* trees, grouped into various age classifications, indicate that the most rapid growth of *Q. laevis* trees occurs during their first 30 years. The data on *Q. cinerea* were not sufficient to justify corresponding observations.*

All bark samples were dried on racks at atmospheric temperature in a forced-air, cross-circulation, lumber drying kiln at the Wood Products Laboratory School of Forestry. Drying was started the same day the samples

TABLE I

Ages and Sizes of Oak Trees Sampled for Bark

Species	Number of Trees	Age Range	Average Age	Average Height	Average Diameter, Outside Bark, at Butt of Trunk	Breast Height	Middle of Trunk	Top of Trunk
		Years	Years	Feet	Inches	Inches	Inches	Inches
Quercus laevis	6	90 - 109	99	17.6	9.8	8.9	7.7	6.6
	8	80 - 89	85	18.0	10.6	9.4	8.5	7.0
	5	60 - 79	65	18.2	9.8	7.8	6.8	5.7
	11	55 - 59	57	21.6	9.1	7.7	6.8	4.2
	6	50 - 54	53	23.6	9.7	8.2	6.8	4.1
	10	40 - 49	45	17.9	8.9	7.6	6.9	5.5
	11	35 - 39	37	18.8	7.9	6.1	4.8	3.2
	8	30 - 34	32	21.1	7.3	5.7	4.7	2.6
	6	10 - 29	14	9.8	3.2	1.9	1.7	0.9
	12	6 - 9	8	9.0	3.2	2.0	1.9	1.1
Quercus cinerea	14	30 - 53	38	16.1	7.4	6.0	5.2	4.3
	21	5 - 29	11	8.4	3.2	2.1	2.2	1.4

were collected, except for samples from Plots A, B and G; the drying of these samples was begun within 48 hours after collection.

Drying required from 4 to 7 days. Each sample of dried bark was passed through a No. 10 Geneva feed chopper, mixed and quartered. A portion was then shipped to the Eastern Regional Research Laboratory for analysis.

Tannin Contents and Purities of Barks

All analyses were made by the Official methods of the American Leather Chemists Association [1]. Table II gives a summary of the results for the 66 trees taken from the 7 plots (A-G). The highest, lowest and average values for each plot are given. The average tannin content of the bark of the *Quercus cinerea* trees was considerably lower than that of the *Q. laevis* trees; in fact it was lower than the lowest value obtained with *Q. laevis*. As expected, there was considerable variation in the tannin content of the bark of individual *Q. laevis* trees, but the average tannin contents of the barks from the 6 plots were in close agreement. They ranged from 9.8 to 11.3 per cent. The over-all average values of 10.5 per cent tannin and 58.8 purity may be considered representative for *Q. laevis* bark in this Florida area.

TABLE II

Tannin Contents and Purities of Barks from 7 Plots*
(Results on moisture-free basis)

Plot	Tannin Content			Purity**		
	Highest	Lowest	Average	Highest	Lowest	Average
	Per Cent					
Quercus cinerea						
A	8.4	5.3	6.7	61.0	52.6	56.0
Q. laevis						
B	11.8	8.4	10.1	64.5	56.4	60.8
C	12.1	7.7	9.8	63.0	54.2	59.0
D	12.6	8.3	10.6	63.3	52.8	58.6
E	13.2	9.0	11.3	61.5	54.5	57.9
F	13.4	7.6	10.4	60.6	50.0	56.6
G	13.6	7.3	10.7	63.6	54.3	60.4
Average (B-G)			10.5			58.8

*Number of trees sampled per plot was 8 for plots A and B, and 10 for plots C to G, inclusive.
**Purity equals 100 X the tannin value divided by the value for soluble solids.

Tannin Contents and Purities of Barks from Different Locations on the Trunk

Table III shows results of analyses of barks from different locations on the one tree taken as representative from each plot (A-G). In *Quercus laevis*, there was a slight decrease in tannin from the bottom to the top of the tree.

Although this decrease is statistically highly significant, it is based on data from only 6 trees and therefore requires confirmation, especially in view of the fact that data in Tables IV and V indicate that barks from the limbs and the top half of the trunk were, in most cases, higher in tannin than bark from the bottom half of the trunk.

TABLE III

Tannin Contents and Purities of Barks from Four Locations* on Trunk
(Results on moisture-free basis)

Plot	Tannin Content				Purity			
	Butt	Breast	Center	Top	Butt	Breast	Center	Top
	Per Cent							
Quercus cinerea								
A	5.4	6.1	6.0	6.6	50.0	53.5	51.3	50.4
Q. laevis								
B	7.9	8.4	7.6	7.8	55.2	56.4	55.5	54.2
C	11.0	9.3	9.7	9.0	62.5	59.2	61.8	57.3
D	10.8	9.8	10.0	9.3	61.7	58.0	58.5	55.3
E	9.4	9.0	9.4	8.7	55.6	54.5	55.6	54.0
F	7.9	7.6	7.0	7.5	52.7	52.4	49.6	51.7
G	9.4	8.8	8.6	8.3	55.6	54.3	53.4	53.2
Average (B-G)	9.4	8.8	8.7	8.4	57.2	55.8	55.7	54.8

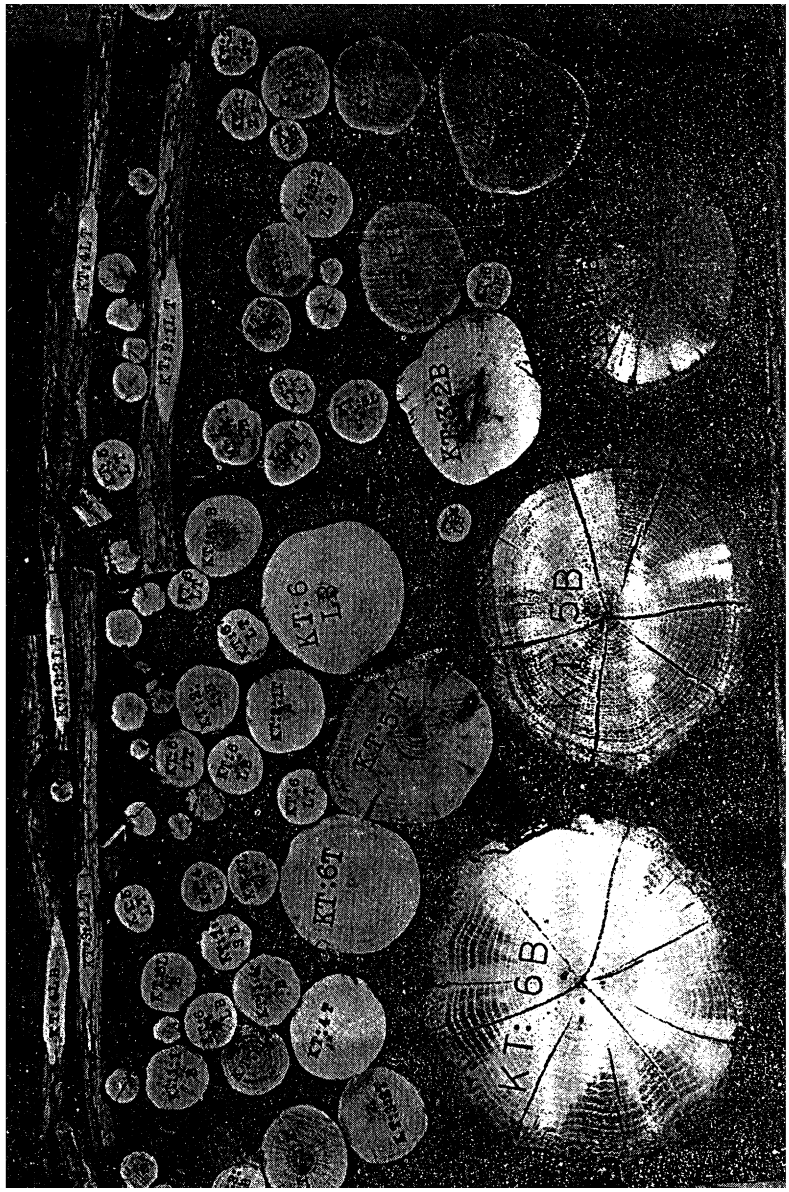
*The locations were: butt (6 inches above the base of the tree); breast height; center point of trunk; and top (6 inches below top end of trunk). Only one tree was sampled in each plot.

Tannin Contents and Purities of Barks from Small Trees and Large Branches

Since the analytical data showed that the bark of *Quercus laevis* contained enough tannin to warrant commercial consideration (Table II), various forestry aspects of the project were investigated[7]. This investigation disclosed that the sampling had not included enough of the smaller trees to be representative of typical stands. For this reason, bark samples were collected from tree trunks having smaller diameters, which had been omitted from the original survey. Samples were collected from trees in the Austin Cary Forest (Plot K.), which had been protected from fires for several years, as well as from trees in a privately owned area (Plot M), which had been subjected to repeated and recent fires. In addition to these, samples from the limbs of all trees having a diameter of 3 inches or larger outside the bark were included.

To obtain sufficient bark from trees less than 5 inches in diameter, it was necessary to fell more than one tree and combine the bark thus obtained for each sample. In collecting samples from trees of 1- and 2-inch diameter, the bark from the entire trunk of each tree was taken and these samples of each species were combined into a single sample. For trees of 3-inch diameter and larger, the bark from the trunk was separated into lower-half and upper-half

portions, which were designated bottom and top sample, respectively. In addition, bark was peeled from all parts of limbs having a diameter of one-half inch or larger and designated limb samples. Table IV shows the results



of analyses of barks for the *Quercus laevis* trees; Table V shows the results for the *Q. cinerea* trees. These results are particularly interesting because they show that the bark from small trees, even 1-inch in diameter, as well as

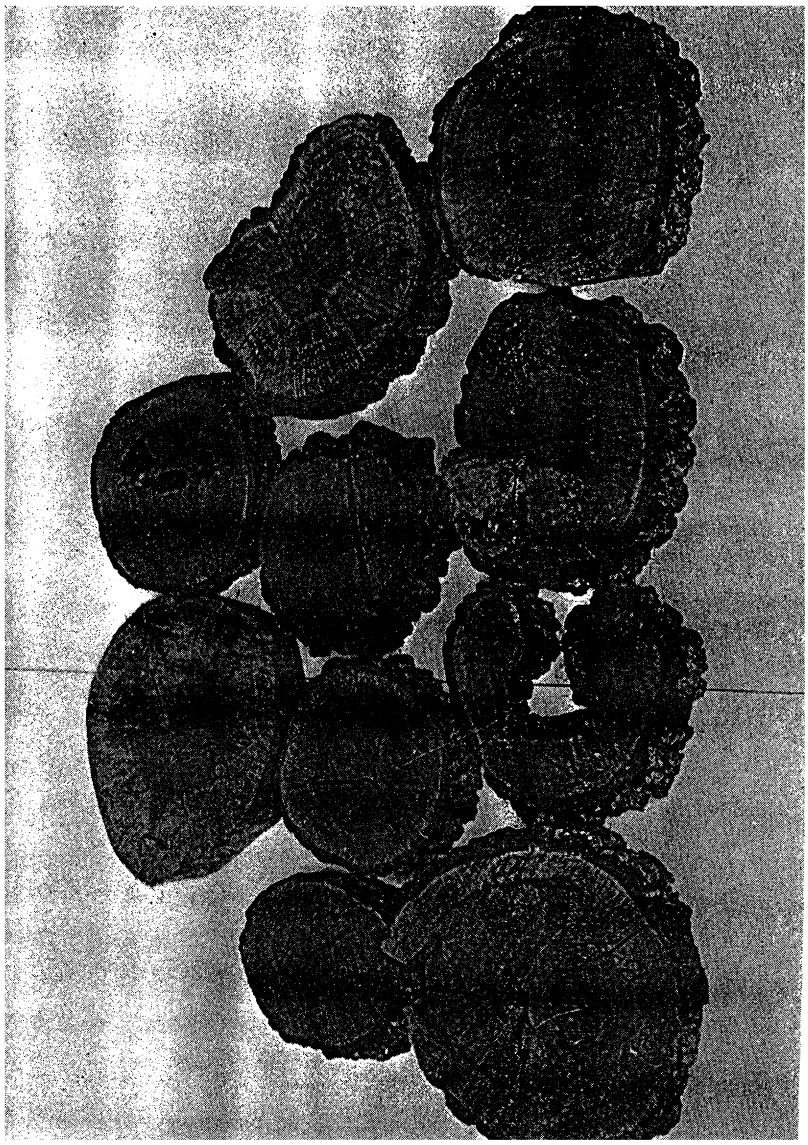


TABLE IV

Tannin Contents and Purities of Barks from Small Trees and Large Limbs of *Quercus laevis* (Results on moisture-free basis)

Diameter of trees	Tannin Content				Purity			
	Whole Tree	Bottom	Top	Limbs	Whole Tree	Bottom	Top	Limbs
Inches	Per Cent							
Plot K (Austin Cary Forest)								
1	11.2				60.2			
2	11.5				60.5			
3		9.6	9.5	10.2		57.8	56.2	57.3
4		10.8	10.7	12.0		60.0	58.2	54.5
5		9.3	10.6	10.8		60.0	58.2	57.8
6		10.1	10.4	11.1		59.8	60.8	56.3
Average	11.3	9.9	10.3	11.0	60.3	59.4	58.4	56.5
Plot M (Privately Owned Area)								
1	10.8				60.3			
2	10.4				58.8			
3		11.3	11.4	10.3		59.2	58.5	51.0
4		9.9	10.6	9.8		56.9	55.8	50.5
5		9.8	11.3	10.0		53.0	55.4	51.3
6		12.0	11.5	10.6		63.8	61.2	53.8
Average	10.6	10.8	11.2	10.2	59.6	58.2	57.7	51.7

TABLE V

Tannin Contents and Purities of Barks from Small Trees and Large Limbs of *Quercus cinerea* (Results on moisture-free basis)

Diameter of trees	Tannin Content				Purity			
	Whole Tree	Bottom	Top	Limbs	Whole Tree	Bottom	Top	Limbs
Inches	Per Cent							
Plot K (Austin Cary Forest)								
1	11.2				61.5			
2	6.5				52.4			
3		5.4	6.6	8.6		51.4	52.4	56.2
4		7.3	8.8	9.7		55.3	58.7	58.8
5		7.2	7.6	7.7		55.4	55.5	53.1
6		6.5	8.5	7.4		53.3	57.8	55.6
Average	8.9	6.6	7.9	8.4	57.0	53.9	56.1	55.9
Plot M (Privately Owned Area)								
1	8.7				62.1			
2	6.0				56.6			
3		7.0	9.3	10.0		56.9	62.0	57.8
4		5.4	7.3	7.0		50.5	54.5	48.3
5		5.2	6.3	7.5		47.3	49.2	48.4
6		6.1	6.8	7.9		54.5	53.5	54.9
Average	7.4	5.9	7.4	8.1	59.4	52.3	54.8	52.4

that from large limbs, contained at least as high a percentage of tannin as the bark from trunks of larger trees. This means that with the proposed method of separating bark and wood, all trees and large limbs in the area could be utilized.

Correlation of Tannin Content with Age and Diameter of Trees

The values for tannin contents of 58 samples of *Quercus laevis* bark have been arranged in Table VI in 10 tannin-range groups. The minimum, maximum and average tannin values for all the samples included in the range are given. The table includes data on the ages and breast-height diameters of the trees from which the samples were collected. An examination of the data in this table shows that there is no correlation between tannin and age or tannin and tree diameter.

TABLE VI

Correlation of Tannin Contents of Barks of *Quercus laevis* Trees with Ages and Breast-height Diameters

Number of Trees	Tannin Content*		Age**		Diameter	
	Range	Average	Range	Average	Range	Average
	Per Cent	Per Cent	Years	Years	Inches	Inches
5	7.3 – 8.2	7.7	39 – 81	56	5.2 – 9.6	7.5
7	8.3 – 8.9	8.7	48 –104	76	6.2 – 11.7	9.0
5	9.0 – 9.3	9.1	45 – 85	60	8.6 – 9.8	9.2
5	9.4 – 9.9	9.8	40 – 89	59	5.4 – 10.0	7.6
7	10.0 – 10.4	10.2	43 –109	79	6.6 – 11.8	8.0
7	10.5 – 10.8	10.7	34 – 68	52	6.4 – 11.0	7.7
5	11.0 – 11.4	11.2	31 – 56	44	5.4 – 8.8	6.9
6	11.5 – 11.8	11.7	36 – 93	50	6.4 – 9.0	7.4
6	11.9 – 13.1	12.3	32 – 92	56	5.8 – 9.3	7.4
5	13.2 – 13.6	13.3	32 – 55	42	7.4 – 9.7	8.2

*Results on moisture-free basis.

**Accurate determination of age was not possible in many instances. Some ages given are therefore in doubt. Trial tabulations in which data from trees of doubtful age were omitted did not change the general conclusions in regard to correlation of tannin with age.

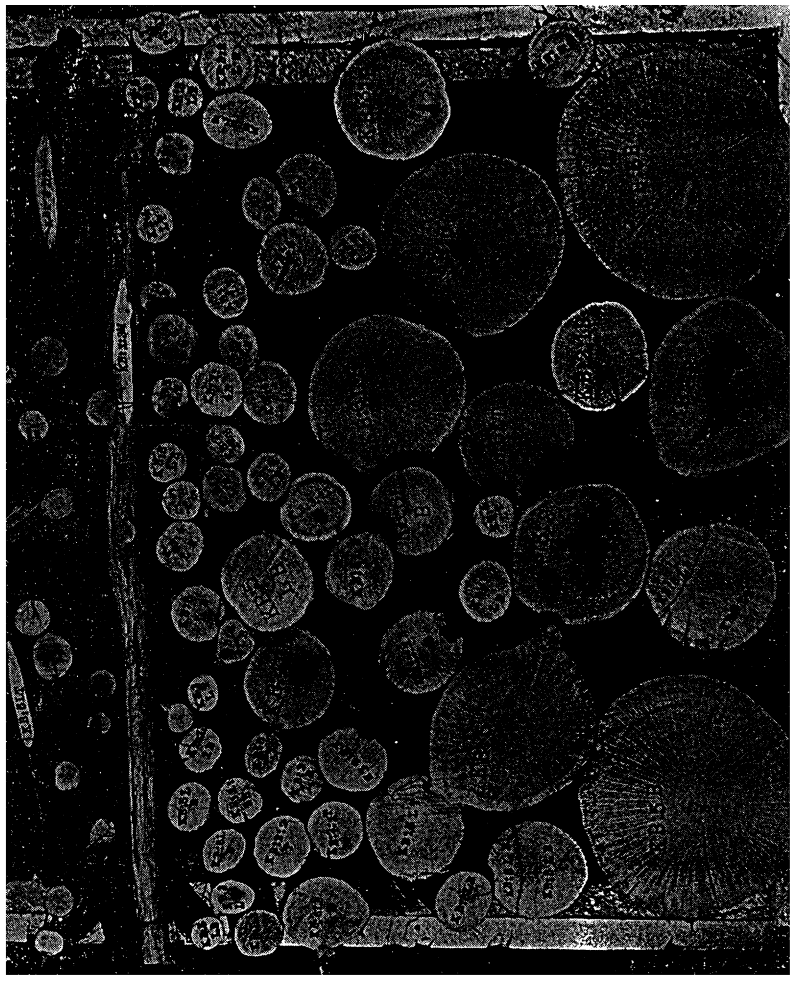
TABLE VII

Correlation of Purities with Ages and Breast-Height Diameters of *Quercus laevis* trees

Number of Trees	Purity		Age		Diameter	
	Range	Average	Range	Average	Range	Average
			Years	Years	Inches	Inches
7	50.1 – 54.8	53.2	45 – 81	56	7.2 – 9.6	8.4
7	54.9 – 56.9	56.2	55 – 109	68	6.9 – 11.5	8.2
6	57.0 – 57.9	57.2	36 – 103	67	7.0 – 9.6	7.8
6	58.0 – 58.9	58.5	31 – 93	61	5.4 – 10.0	7.9
5	59.0 – 59.4	59.2	43 – 84	59	6.2 – 9.8	7.4
8	59.5 – 59.7	59.6	36 – 104	56	5.2 – 11.8	8.4
6	59.8 – 60.7	60.2	32 – 59	45	6.4 – 9.7	7.7
5	60.8 – 62.3	61.6	52 – 93	71	6.3 – 11.0	8.6
8	62.4 – 64.5	63.6	32 – 92	47	5.4 – 8.1	6.8

Since the quality of bark depends on purity as well as tannin content, a comparison was made of purity with the age and diameter of the tree. Table VII gives these data. Here again it will be noted that there is no correlation.

Most of the bark samples were collected from September 15 to January 15 in different years. During this time of year, these oaks are either dormant or are becoming dormant, and the tannin content of the bark may be different from that at other seasons. Although a study of seasonal variations in the tannin content of bark was not originally planned, some tannin determinations were made on barks collected at various seasons of the year. The results are of particular interest because they indicate that there may be an optimum



time for collection. Table VIII shows the data obtained. The tannin contents and purities of barks from trees that had attained full leaf were noticeably higher than those of barks collected at other times of the year. These results are in harmony with statements by Haas and Hill [11], Hartig [12] and Trimble [27], but because of the limited number of samples examined, the results should be confirmed by a more extended study.

TABLE VIII

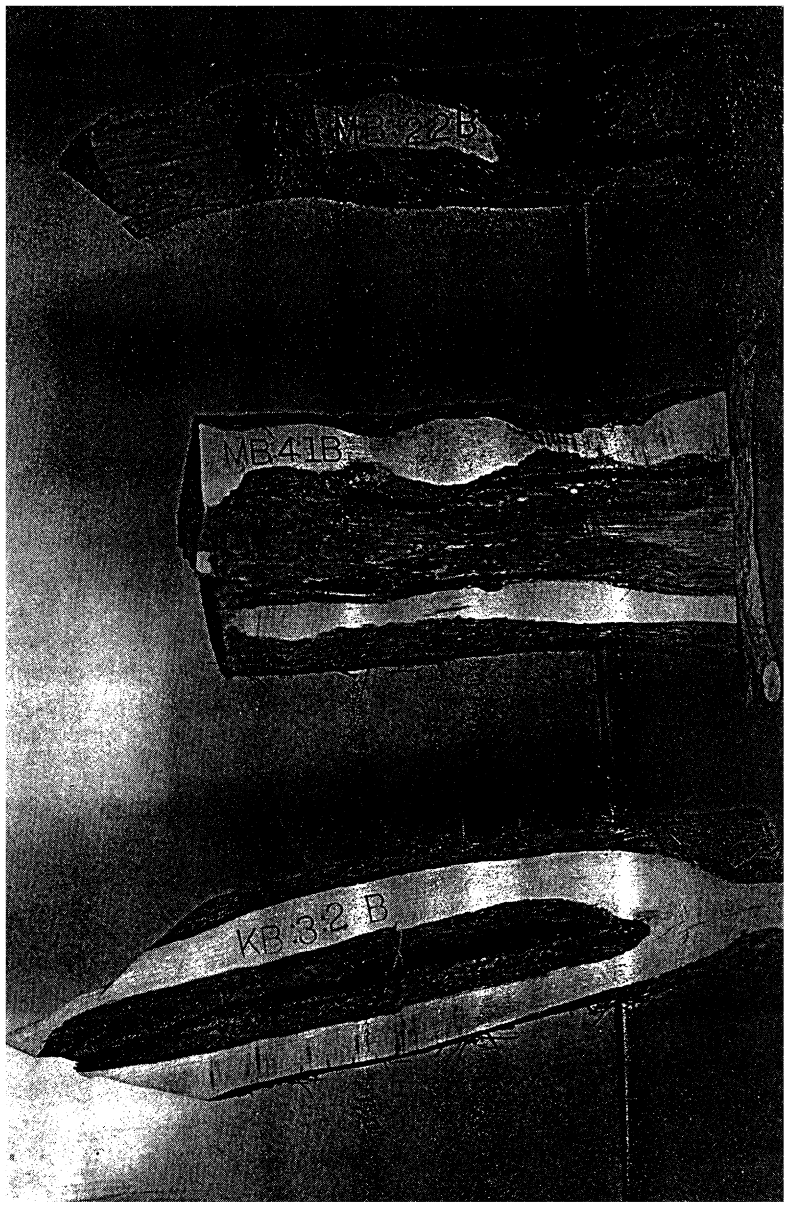
Seasonal Variation in Tannin Contents and Purities of Barks from *Quercus laevis*

Stage of Growth	Date Sampled	Number of Samples	Tannin Content*		Purity	
			Range	Average	Range	Average
			Per Cent	Per Cent		
Dormant	1–23–45	5	9.4–10.7	9.7	54.3–59.0	56.1
Winter buds had just opened	3–1–45	2	8.7–10.0	9.4	54.3–56.8	55.6
Flowers had appeared; new leaves about 1 inch in width	3–7–45	4	8.1–13.1	11.7	60.8–62.0	61.2
Had just attained full leaf	4–25–44	2	13.8–16.5	15.2	66.0–68.0	67.0

After drying, tannin-containing bark is usually stored commercially under cover, but is exposed to changing atmospheric conditions without deleterious effects. However, it is possible that these barks would be more hygroscopic than other types of bark, and that the small pieces produced by the mechanical chipping process [6], in the humid conditions of Florida might absorb sufficient water to promote damaging biological action. A series of drying tests showed that under normal drying conditions the bark was not appreciably hygroscopic and no damage resulted from storage. It is probable, however, that because of the fine state of subdivision and the nature of the Florida climate, more than usual care should be taken to prevent actual wetting of bark by rain, fog, or other causes.

Quercus laevis and *Q. cinerea* barks were used at the Eastern Regional Research Laboratory in tests on leaching and preparation of extract. The bark was ground to a suitable particle size and leached in a countercurrent system by a method similar in principle to that used in commercial practice. Leaching was as satisfactory and tannin recovery as high as with other tannin-containing barks now in use. The liquors were concentrated in vacuum to liquid extracts containing 40 per cent total solids; the extracts were dried to a powder in a vacuum drum dryer. Table IX shows the analyses of these extracts. Although the extract made from *Q. cinerea* bark showed a tannin content of 46.1 per cent and a purity of 55.3, indicating that it was of lower qual-

ity than most oak bark extracts, it was considered suitable for blending with other extracts. The extract made from *Q. laevis* bark contained 58.0 per cent tannin and had a purity of 61.9. It was somewhat better in quality and com-



pared favorably with commercial oak bark extracts. The extract from *Q. cinerea* bark contained an excessive amount of insolubles, which could be reduced by settling before concentrating. Laboratory tanning tests with the *Q. laevis* extract showed that it had satisfactory tanning powers.

TABLE IX

Analyses of Vacuum Drum-Dried Tanning Extracts from Barks of *Quercus cinerea* and *Q. laevis*

	Q. Cinerea	*Q. laevis*
	Per Cent	Per Cent
Total solids	95.8	94.8
Soluble solids	83.4	93.7
Insolubles	12.4	1.1
Non tannins	37.3	35.7
Tannin	46.1	58.0
Purity	55.3	61.9

Discussion

Field work disclosed that blackjack oak, *Quercus marilandica Muenchh.*, could be excluded from this study because it grew in only a small section of western Florida and occurred there only to a limited extant. However, the literature [16, 23] indicates that the tannin in its bark is suitable both in quantity and quality for tannery use. If the color is found to be unobjectionable, the bark might be mixed with barks from other suitable and more abundant species of oaks.

Bluejack oak, *Quercus cinerea*, the other species selected for study, occurs to a small extent as an associate of both *Q. Marilandica* and *Q. laevis*. The data in Table I indicate that *Q. cinerea* and *Q. laevis* do not differ materially in rate of growth or size up to about 30 years of age. Beyond that age, *Q. laevis* increases in size more rapidly than *Q. cinerea*. The data obtained on barks from Plot A, Table II, show a tannin content lower than that reported in the literature [16, 23] and probably close to the values to be expected from a commercial bark operation. The lower tannin content and purity of *Q. cinerea* bark, as compared with those of *Q. laevis* bark, would probably prohibit its use alone, but if it occurred in small quantities with *Q. laevis* it might be used in mixture with that bark without difficulty.

Of the three species considered in this survey, Turkey oak, *Q. laevis*, received the most attention because it was the only one that occurred in sufficient amounts to warrant commercial exploitation. At present, because of its scrubby growth, it is practically valueless except for local use as a fuel. The data in Table I indicate the "scrubby" characteristics of this species. Of the 60 trees sampled, only 3, each more than 80 years old, were large enough to yield 7 x 8-inch railroad cross-ties. Because of the damage to their bases by fire or disease, the ages of 20 per cent of the trees could not be determined. Almost 25 per cent were known to be more than 80 years old, and this value would probably be increased to 30 per cent if damaged trees were included.

On the basis of the data obtained, there is no correlation between tannin content or purity and the age or size of trees. Because the tannin values in Table III were obtained on samples of bark from one tree in each plot, they are not so reliable as those in Table II, which are average values for 8 or 10 trees in each plot. The barks from small trees and limbs were as high in tannin and purity of extractive as those from large trees. Yields of bark per unit of tree volume were also high. In present stands of Florida scrub oak, small trees predominate. However, because of suppressed growth and severe fire injury, they are of so little value that they are unsuitable for retention in a sustained yield program. Their removal and recovery of their bark by a mechanized process such as that proposed by Calderwood [6], would be advantageous in any plan for placing stands of scrub oak on a proper sustained yield basis.

From data obtained on bark yields by Calderwood and May [7] and data on the average tannin content of bark from Plots B-G inclusive, it has been estimated that the potential yield of 25 per cent tannin extract is approximately 1 ton per acre of an average stand of Florida *Q. laevis*. This estimate is based on the following factors:

Average yield of green wood per acre,	10 cords
Average weight of green wood per cord,	4700 lbs.
Average per cent by weight of bark on green wood,	23.4 per cent
Average moisture content of green bark,	44 per cent
Average tannin content of moisture-free bark,	10.5 per cent
Leaching efficiency for extraction of tannin,	80 per cent

Summary and Conclusions

Study of age and size of *Quercus laevis* trees indicated that in this species most rapid growth occurs during the first 30 years.

Study of barks from tree trunks from 6 plots of *Quercus laevis* showed (on a moisture-free basis) an average tannin content of 10.5 per cent and a purity of 58.8, as compared with an average of 6.7 per cent tannin and a purity of 56.0 for barks from one plot of *Q. cinerea*.

The tannin contents of barks collected at four heights on one tree trunk in each of 6 plots indicated that tannin content decreased from butt to top of trunk but this was not confirmed by later tests, in which barks from lower and upper halves of trunks were compared.

The tannin contents of bark from small trees were as follows:

Part of Tree	Diameter, Inches	Average Tannin Content, per cent
Quercus laevis		
Whole tree	1–2	10.9
Bottom half of trunk	3–6	10.3
Top half of trunk	3–6	10.7
Limbs	3.6	10.6
Quercus cinerea		
Whole tree	1–2	8.1
Bottom half of trunk	3–6	6.2
Top half of trunk	3–6	7.6
Limbs	3–6	8.2

No correlation was found between tannin contents of barks and ages or diameters of trees for either *Quercus laevis* or *Q. cinerea.*

Bluejack oak, *Quercus cinerea* Michx., does not occur in extensive stands in Florida, but it is frequently an associate of Turkey oak, *Quercus laevis*, usually comprising less than 10 per cent of the stands. Its bark contains less tannin, and the extractives are lower in purity than those of Turkey oak. *Quercus cinerea* bark is probably unsuitable for use alone, but might be used in small quantities with Turkey oak bark.

Seasonal variations in the tannin content of bark were not studied in detail, but the results obtained on a few samples indicate that there may be an optimum time for bark collection. This, however, requires confirmation.

Results of this investigation indicate that from average stands of *Quercus laevis* yields of about 1 ton of 25 per cent tannin extract should be possible per acre.

This study has demonstrated that barks from *Quercus laevis* trees contain tannin averaging more than 10 per cent and are suitable in quality for production of tanning extracts.

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Survey, Field Work and Bark Collection

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Chemical Investigations

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